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# Validating The ISO 9000 Construct of Measurement Instrument Through Application of RASCH Model

Rohaizah Saad[1*], Rushami Zein Yusuff[2], Zakaria Abas[3], Azrilah Abd Aziz[4], Mohd Saidfudin Masodi[5]

[1]College of Business, Universiti Utara Malaysia, [2]College of Business, Universiti Utara Malaysia [3]College of Business, Universiti Utara Malaysia, [4]Consultant Psychometrician, Integrated Advance Planning Sdn Bhd, [5]Program Coordinator, Exec. Dip in QMS/QMS ISO 9000 Lead Assessor

***ABSTRACT***

*There are numerous researches conducted on the issues related to ISO 9001 quality management system. Among the issue is the impact of the ISO 9001 quality management system implementation on the performance of the organization. However the findings from the research appeared as inconclusive. Few literature suggest that the inconclusive result may due to the level of ISO 9000 implementation therefore further research is required. Generally the data collected for these types of researches are through mailed questionnaires and analyzed it using SPSS and SEM. In line with that this study also developed questionnaires correspond to a 5 point Likert to assess the implementation of ISO 9000 in the organization. As a result 231 items are identified within five dimensions. The five dimensions are derived from ISO 9001 and ISO 9004 quality management standards requirement and guidelines. Among the dimensions are management responsibility, resource management, product realization, measurement improvement and innovation and organizational performance. The questionnaires are sent to 78 automotive based companies located in the Northern region of Peninsular Malaysia. 19 questionnaires were returned and used as pilot test to validate and calibrate the instrument. The responds from the organization are tabulated and run in WinSteps software for the purpose of validating and calibrating the instrument by implementing the Rasch 'quality control' and reduction of items. Not all the outfit items are removed from the instruments, Rasch Model did provide room for the researcher to make decision either to remove or not those outfit items. In this study those outfit items need to be corrected in order to ensure that the instrument is reliable and fit to measure the performance of the organization. As a result 68 items are removed from the questionnaires.*

*Keyword: rasch model, ISO 9001, quality control and items reduction.*

* Correspondence author. Email: rohaizas@yahoo.com

## 1. Introduction

Quality has emerged as a strategic competitive tool for organizational success in the domestic and international market (Kartha, 2004). Organizations have realized that the key to increase productivity and profitability is improving quality of product and services. The concept of quality was emerged way back in 18 century during the time of Juran and Deming. Along the period many concepts and techniques of quality have been developed and adopted to improve the standard of service and quality of products. And many organizations have reviewed that an effective quality management can enhance their competitive abilities and provide strategic advantages in the marketplace (Anderson, Rungtusanatham, & Schroeder, 1993).

There are numerous quality management system in the market. And ISO 9000 is the most popular quality management system since it is always considered as a base towards the total quality management (Chow-Chua, Goh, & Wan, 2003; Franceschini, Galetto, & Cecconi, 2006). It is also the fastest growing quality system in the world. According to the latest statistics released by the ISO, (2009b), as of the end of December 2009, 178 countries, with 1.1 million certifications world wide. The number of certifications has increased from year to year. Due to the wide acceptance of ISO 9000 has led to considerable interest in the research literature.

Among the issues discussed in the literature are motives of ISO 9000 certification, the benefit derived from the ISO 9000 implementation, the ISO 9000 criticism, its impact on organizational performance and its relationship with total quality management (TQM) (Psomas & Fotopoulos, 2009). Empirically, ISO 9000 has been proven to help the improvement of performance of the organization (Zain & Ahmad, 2000). However Feng, Terziovski, & Samson (2008) stated that there are some conflicting findings on the bottom-line effects of ISO certification and the practices which lead to successful implementation. This conflicting result may due to the commitment to implement the ISO 9000 requirements. As suggested by Lee, To, & Billy (2009) organization can be classified into cluster in which some organizations implement the principles of ISO 9000 to the extent that certification can be obtained and some organizations implement the principles to level beyond the standard requirements. However this study is an exploratory work with a limited sample size. Due to that this research will extend this idea to empirically test the correlation between the ability of an organization in performing ISO 9000 standard requirements and lead to organizational performance.

Generally the studies related to quality management systems involving collecting quantitative data through questionnaire survey. And most of the data collected in the form of ordinal data and the output was analyzed using the statistical method SPSS or SEM which is in the form of raw scores. The raw score is only giving a ranking order which deemed an ordinal data and is of continuum in nature and not an interval scale. Due to that Rasch analysis model was adopted to analysed the level of ISO 9000 adoption and its ability in achieving organizational performance. Rasch Model through WinSteps software be able to transform ordinal data into ratio data in the form of logit value.

Most of the instruments under ISO 9000 quality management system are developed based on quality management principles and TQM concepts (Lee et al., 2009; Padma, Ganesh, & Rajendran, 2006; Saraph, Benson, & Schroeder, 1989) rather than using the ISO 9000 clauses itself. Since this study attempts to investigate the level of ISO 9000 implementation in relation to organizational performance the details questionnaires was developed. It was developed based on extensive literature review and also expert opinion involving management representative in the organization. Before further research was conducted it is important to ensure the instrument used is valid and reliable. Due to the importance of reliable instrument, the instrument should represent what it is supposed to measure, hence the objective of this paper is to conduct an exercise to check the reliability of the instruments using Rasch Model. Rasch Model is able to provide method in checking the reliability and quality of the instrument (Fisher, 2008).

## 2. Measurement method

### 2.1. Sample

The objective to this study is to evaluate the performance of automotive base companies located at Northern Region of Malaysia based on their ISO 9000 exercise. There are about 78 companies were involved in the automotive industry at the Northern region but only 19 companies returned the questionnaire and participated in the survey.

### 2.2. Instruments development

The questionnaire used in this research was developed based on ISO 9000 quality management standard requirements and guidelines, also from exhaustive literature review and expert opinion from appointed management representative in the organization. The questionnaire was designed to evaluate the ability of organization to perform items under ISO 9000. The questionnaire consisted of 231 questions separated into five dimensions or four independent variables and one dependent variable.

The five dimensions were management responsibilities, resource management, product realization, measurement, analysis and improvement which is according to ISO 9000 standard requirement and organizational performance. Those five dimensions were supported by sub-dimensions. Those dimensions are tabulated in the following table 1. The ability of responses were categorized using Likert scale rank from "1" very low to "5" very high (Sekaran, 2003).

Table 1: List of dimensions

| Dimension | Sub-dimension |
|---|---|
| Management responsibility | Management commitment |
| | Customer focus |
| | Strategy and policy deployment |
| | Responsibility, authority and communication |
| Resource management | Financial resources |
| | Human resources |
| | Partners and suppliers |
| | Infrastructure and work environment |
| Product realization | Planning of product realization |
| | Product design and development |
| | Purchasing |
| | Production and service operations |
| Measurement and analysis | Measurement and analysis |
| | Improvement, innovation and learning |
| Organizational performance | Financial performance |
| | Non-financial performance |

Current practice of measuring performance is only counting the responses of priorities from the organizations. The rating is only an order of preference; which is continuum in nature and it is not linear and also do not have equal intervals which contradict with the nature of numbers for statistical analysis (Aziz et al., 2008; B. D. Wright, 1997b). In Traditional Test, the scatter plot is applied to establish the best regression. However prediction from ordinal response is almost impossible due to absence of intervals scale. The normal solution in linear regression approach is to establish a line which fits the points as best as possible; which is then used to make the required predictions by inter-polation or extra-polation as necessary (Aziz et al., 2008; Aziz, Mohamad, Arshad, Zakaria, & Masodi, 2007) as shown in Figure 1.

(1)

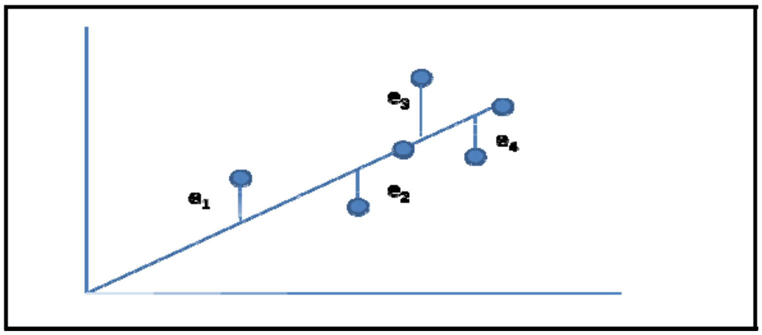



Figure 1. Best fit line concept

In obtaining the best fit line, however, there exist differences between the actual point; $y_i$, and predicted point; , that is on best fit line. The difference is referred as error, e

(2)

Since there is always errors involve in the prediction model, the deterministic model of equation (1) renders itself less reliable. This can be overcome by transforming it into a probabilistic model by including the prediction error into the equation;

(3)

Under the Rasch philosophy the data collected have to fit the Rasch model's specification (Aziz et al., 2007; Bond & Fox, 2007) rather than establishing "best fit line". Rasch moves the concept of reliability from establishing "best fit line" of the data into producing a reliable repeatable measurement instrument Wright & Mok et al, (2004) extracted from Aziz et al. (2008). Rasch focuses on constructing the measurement instrument with accuracy rather than fitting the data to suit a measurement model with of errors. By focusing on the reproducibility of the latent trait measurement instead of forcing the expected generation of the same raw score, i.e the common expectation on repeatability of results being a reliable test, the concept of reliability takes its rightful place in supporting validity rather than being in contentions. In Rasch it is required to test whether the data allow for measurement on linear interval scale specifically in a cumulative response process i.e. a positive response to an item stochastically implies a positive response to all items being easy or otherwise.

Rasch Model is expressed as the ratio of an event being successful as;

$$P(\theta) = \frac{e^{(\beta n - \delta_i)}}{1 + e^{(\beta n - \delta_i)}} \quad (4)$$

where:

e = base of natural logarithm or Euler's number; 2.7183

βn = person's ability

δi = item or task difficulty

Rasch exponential expression is a function of Logistic Regression which resulted in a Sigmoidal ogive and can be transformed into simpler operation by reducing the indices by logarithm:

$$\ln[P(\theta)] = \ln\left[\frac{e^{(\beta n-\delta_i)}}{1+e^{(\beta n-\delta_i)}}\right] \quad (5)$$

Now ln[P(θ)]; as the probability of a successful event; x=1 is reduced to the expression termed *logit* and can be construed simply as the difference of person ability; βn and the item difficulty; δi, which can be represented as;

$$\ln[P(\theta)] = \beta n - \delta i \quad (6)$$

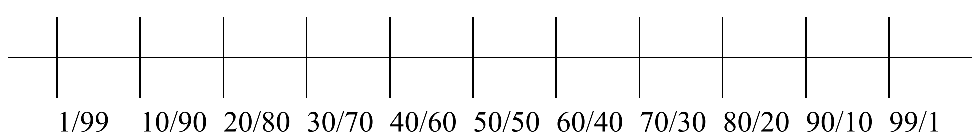
The main reason why the transformation into *logit* is required is to obtain a linear interval scale. It can be shown mathematically that a series of numbers irrespective of based used is not equally spaced but distant apart exponentially as the number gets bigger while a log series maintain their equal separation; thus equal interval (Aziz et al., 2008). The Table 2 below shows the equal separation and term it as *logit* as measurement of ability. The difference between $\log_{10}5$ and $\log_{10}2$ is constant and remain of equal distant between $\log_{10}50$ and $\log_{10}20$. Similarly for $\log_e$; hence *logit*.

Table 2. Comparison of Numerical and Log intervals

| **Numerical series** | **$\log_{10}$** | **$\log_e$** |
|---|---|---|
| 1 | 0.000 | 0.000 |
| 2 | 0.301 | 0.694 |
| 5 | 0.699 | 1.609 |
| 10 | 1.000 | 2.303 |
| 20 | 1.302 | 2.997 |
| 50 | 1.699 | 3.912 |
| 100 | 2.000 | 4.606 |

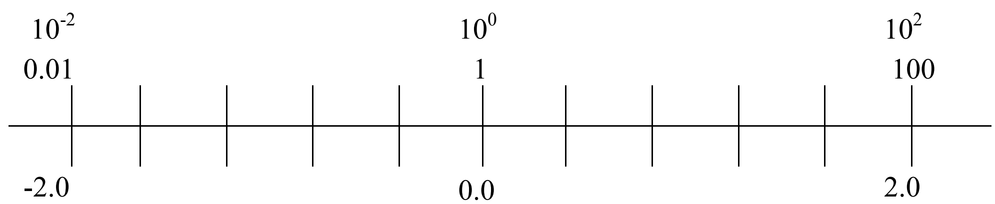
Rasch is a probabilistic model it is about the chances of choosing of one rank not the others. It involves the odd ratio. The Figure 2 below shows the probabilistic line diagram while Figure 3 shows the *logit* ruler.

Figure 2. Probabilistic line diagram




In order to achieve an equal internal scale, the logarithm used for odd probabilistic value in Figure 2 above. For example the value of 1/99 is equivalent to $10^{-2}$ when $\log_{10}$ apply to it, then $\log_{10}10^{-2}$ is equal to -2.0; value of $\log_{10}10^{-1}$ equals to -1; value of $\log_{10}1$ equals to 0 and so forth. The Figure 3 below shows the newly established *logit* ruler as linear scale with equal interval separation.

Figure 3. Logit ruler




Based on the above theorem the rank order data can be transformed into equal interval separation

## 4. Data analysis

As mentioned earlier the purpose of this paper is to check on the reliability and calibrate the instrument used before further analysis is conducted. An instrument also shall also have the correct construct of linear scale which can be zero set and duly calibrated. A valid instrument can then be replicated for independent use of the subject hence measurement taken thereof is therefore a reliable data for meaningful analysis and examination to generate useful information (Saidfudin et al., 2010). However to further validate the construct validity, Rasch analysis provides indicators of how well each item fits within underlying construct. The concept of fit is a “quality-control mechanism” and it is important to ascertain whether the assumption of unidimensionality holds up empirically (Bond et al., 2007). Therefore the instrument is subjected to validity and reliability.

In classical test theory reliability and validity measures are from Cronbach-α and Factor analysis. However Rasch Modeal which is in line with the concept of modern test theory known Item Response Theory (IRT) goes beyond this measurement by focusing on the reproducibility of measures rather than expressing the reproducibility of raw scores (Aziz et al., 2007).

The total respondent involved in this pilot test is 19 and their organization located at Northern Region. The data from the survey was analyzed using Rasch Model statistical computer software program, Winstep 3.68.2 (Bond et al., 2007). In order to analyze how good the data collected fit the Rasch model, Summary Statistic Table as per Table 3 provides the overall summary statistic.

Table 3. Summary statistic

Validating ISO 9000 instrument
INPUT: 19 Person 231 Item MEASURED: 19 Person 231 Item 5 CATS WINSTEPS 3.69.1.16

SUMMARY OF 19 MEASURED **Person**

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 857.8 | 230.6 | 1.56 | .11 | .99 | -.9 | .99 | -.9 |
| S.D. | 108.5 | 1.6 | 1.24 | .01 | .49 | 4.9 | .50 | 5.1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MAX. | 1077.0 | 231.0 | 4.53 | .14 | 2.30 | 9.7 | 2.29 | 9.7 |
| MIN. | 580.0 | 224.0 | -1.26 | .09 | .34 | -9.1 | .31 | -9.9 |

REAL RMSE .12 TRUE SD 1.23 SEPARATION 10.29 Person RELIABILITY .99
MODEL RMSE .11 TRUE SD 1.23 SEPARATION 11.22 Person RELIABILITY .99
S.E. OF Person MEAN = .29

Person RAW SCORE-TO-MEASURE CORRELATION = .99
**CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .99**

SUMMARY OF 231 MEASURED **Item**

| | TOTAL SCORE | COUNT | MEASURE | MODEL ERROR | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD |
|---|---|---|---|---|---|---|---|---|
| MEAN | 70.6 | 19.0 | .00 | .38 | .98 | -.1 | .99 | -.1 |
| S.D. | 5.8 | .2 | .78 | .02 | .41 | 1.1 | .48 | 1.2 |
| MAX. | 82.0 | 19.0 | 3.34 | .42 | 3.78 | 5.5 | 4.92 | 6.8 |
| MIN. | 43.0 | 18.0 | -1.76 | .33 | .29 | -2.9 | .31 | -2.8 |

REAL RMSE .40 TRUE SD .66 SEPARATION 1.65 Item RELIABILITY .73
MODEL RMSE .38 TRUE SD .68 SEPARATION 1.79 Item RELIABILITY .76
S.E. OF Item MEAN = .05

From the above table the Cronbach-alpha (α) value is at 0.99 which is consider acceptable reliability as Cronbach-alpha should be more than 0.60 (Nunnally & Bernstein, 1994). Generally this instrument is reliable in measuring the constructs (Sekaran, 2003). However in Rasch the reliability issues are discussed further in term of person reliability and item reliability. The person reliability and item reliability index provided in the above Table 3 indicates the replicability of person ordering and item placements respectively along the *logit* scale (Bond et al., 2007). The person reliability index is given at 0.99 which is deemed 'Excellent' reliability (Fisher, 2007), showing the stability of the person response validity. Item reliability index is at 0.73 which is of 'Fair'reliability (Fisher, 2007), inferring that the assessment tool can discriminate the person ability and the difficult item. This is the very crucial test as it determines the construct validity of the instrument hence valid data (Andrich, 1988; Bond et al., 2007).

The $Mean_{Item}$ is always set at 0.00 *logit* and the $Mean_{Person}$ is observed at 1.56 *logit*. This indicates that the organization involved in this study in general have the ability to reach the items prescribed in the study. The most difficult item is located at 3.34 *logit* and the easiest item is located at -1.76 *logit* with the standard deviation of 0.78 *logit* which inferring to the small spread within the data. While the maximum *logit* for person is 4.53 *logit* and the minimum *logit* for person is -1.76 *logit* and the range is 6.29 *logit* which indicate a bigger spread among the respondents. The data also shows that there are respondents above the maximum item *logit* which indicates respondent's excellent ability in performing the items.Rasch analysis generates useful information in ensuring the data fit the model, the measures are Point Measure correlation (PtMea Corr), Outfit Mean Square (MNSQ) and z-Standard Test. These measures are used as 'quality control' to ensure the data can be used for further analysis. The guidelines given by Fisher, (2007) the quality control value for Pt-Mea Corr should lies between 0.40 and 0.80, MNSQ should be within 0.5 and 1.5 and the z-standard should be between -2 and 2.

The result above shows that certain items in the instruments are outside the 'quality control' range. Those items are per_nfin7 and mm_inv8.2 with MSSQ is 4.92 and 0.31 respectively. Therefore further analysis is required to determine which items are required to improve or removed from the instrument.

Misfit order report provides a guideline which items need to be considered. The Table 4 below shows the Misfit Order report.

Table 4. Item statistic Misfit Order

Validating ISO 9000 instrument
INPUT: 19 Person 231 Item MEASURED: 19 Person 231 Item 5 CATS WINSTEPS 3.69.1.16

Person: REAL SEP.: 10.29 REL.: .99 ... Item: REAL SEP.: 1.65 REL.: .73

Item STATISTICS: MISFIT ORDER

| ENTRY NUMBER | TOTAL SCORE | TOTAL COUNT | MEASURE | MODEL S.E. | INFIT MNSQ | INFIT ZSTD | OUTFIT MNSQ | OUTFIT ZSTD | PT-MEASURE CORR. | PT-MEASURE EXP. | EXACT MATCH OBS% | EXACT MATCH EXP% | Item |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 226 | 43 | 19 | 3.34 | .34 | 3.29 | 4.8 | 4.92 | 6.8 | A -.10 | .63 | 21.1 | 51.4 | per_nfin7 |
| 227 | 47 | 19 | 2.89 | .33 | 3.78 | 5.5 | 4.63 | 6.5 | B -.12 | .64 | 15.8 | 51.5 | per_nfin8 |
| 224 | 51 | 19 | 2.45 | .33 | 2.40 | 3.3 | 2.36 | 3.3 | C .25 | .64 | 26.3 | 54.4 | per_nfin4 |
| 225 | 59 | 19 | 1.54 | .34 | 2.40 | 3.3 | 2.39 | 3.3 | D .18 | .64 | 42.1 | 53.0 | per_nfin6 |
| 187 | 59 | 19 | 1.54 | .34 | 1.93 | 2.5 | 1.85 | 2.3 | E .65 | .64 | 31.6 | 53.0 | mm18.4 |
| 37 | 68 | 19 | .41 | .37 | 1.91 | 2.3 | 1.71 | 1.9 | F .41 | .62 | 47.4 | 59.3 | rm_hrm_invl22 |
| 48 | 70 | 19 | .14 | .38 | 1.85 | 2.1 | 1.69 | 1.8 | G .46 | .61 | 57.9 | 61.6 | rm_ps39 |
| 228 | 78 | 19 | -1.08 | .40 | 1.82 | 2.2 | 1.73 | 1.9 | H .52 | .57 | 31.6 | 62.5 | per_nfin9 |
| 219 | 71 | 19 | -.01 | .38 | 1.81 | 2.0 | 1.77 | 2.0 | I .74 | .61 | 42.1 | 62.6 | per_fin3 |
| 217 | 47 | 19 | 2.89 | .33 | 1.72 | 2.0 | 1.76 | 2.1 | J .38 | .64 | 36.8 | 51.5 | per_fin1 |
| 142 | 75 | 19 | -.60 | .39 | 1.75 | 1.9 | 1.73 | 1.9 | K .40 | .59 | 57.9 | 62.9 | pr_seo34.2 |
| 221 | 66 | 19 | .68 | .36 | 1.73 | 2.0 | 1.73 | 2.0 | L .44 | .62 | 42.1 | 55.7 | per_fin6 |
| 45 | 63 | 19 | 1.06 | .35 | 1.68 | 1.9 | 1.66 | 1.9 | M .69 | .63 | 47.4 | 52.3 | rm_hrm_emp36 |
| 43 | 61 | 19 | 1.30 | .35 | 1.63 | 1.8 | 1.65 | 1.8 | N .29 | .63 | 52.6 | 51.9 | rm_hrm_emp33 |
| 79 | 75 | 19 | -.60 | .39 | 1.59 | 1.6 | 1.63 | 1.7 | O .46 | .59 | 63.2 | 62.9 | pr_plan11.12 |
| 220 | 69 | 19 | .28 | .37 | 1.55 | 1.5 | 1.62 | 1.7 | P .56 | .62 | 42.1 | 60.4 | per_fin5 |
| 38 | 64 | 19 | .93 | .35 | 1.60 | 1.7 | 1.57 | 1.6 | Q .71 | .63 | 42.1 | 52.9 | rm_hrm_invl25 |
| 44 | 64 | 19 | .93 | .35 | 1.51 | 1.5 | 1.54 | 1.6 | R .54 | .63 | 68.4 | 52.9 | rm_hrm_emp34 |
| 47 | 62 | 19 | 1.18 | .35 | 1.49 | 1.5 | 1.45 | 1.4 | S .51 | .63 | 36.8 | 52.4 | rm_ps38 |
| 130 | 71 | 19 | -.01 | .38 | 1.36 | 1.1 | 1.46 | 1.3 | T .55 | .61 | 52.6 | 62.6 | pr_pur26.1 |
| 144 | 70 | 19 | .14 | .38 | 1.45 | 1.3 | 1.37 | 1.1 | U .49 | .61 | 52.6 | 61.6 | pr_seo34.5 |
| 138 | 71 | 19 | -.01 | .38 | 1.45 | 1.3 | 1.41 | 1.2 | V .56 | .61 | 47.4 | 62.6 | pr_pur31 |
| 104 | 71 | 19 | -.01 | .38 | 1.41 | 1.2 | 1.35 | 1.0 | W .53 | .61 | 57.9 | 62.6 | pr_pd18.5 |
| 222 | 75 | 19 | -.60 | .39 | 1.39 | 1.1 | 1.38 | 1.1 | X .45 | .59 | 63.2 | 62.9 | per_nfin1 |
| 131 | 73 | 19 | -.30 | .39 | 1.39 | 1.1 | 1.39 | 1.1 | Y .76 | .60 | 47.4 | 63.6 | pr_pur26.2 |
| 140 | 70 | 19 | .14 | .38 | 1.21 | .7 | 1.38 | 1.1 | Z .27 | .61 | 63.2 | 61.6 | pr_pur33 |
| 6 | 73 | 19 | -.30 | .39 | 1.32 | 1.0 | 1.35 | 1.0 | .63 | .60 | 47.4 | 63.6 | mr_mc8 |
| 96 | 65 | 18 | .33 | .38 | 1.28 | .9 | 1.34 | 1.0 | .68 | .63 | 50.0 | 60.3 | pr_pd15.6 |
| 122 | 73 | 19 | -.30 | .39 | 1.33 | 1.0 | 1.32 | 1.0 | .28 | .60 | 63.2 | 63.6 | pr_pur25.1 |
| 137 | 77 | 19 | -.92 | .40 | 1.19 | .7 | 1.33 | 1.0 | .24 | .58 | 52.6 | 62.5 | pr_pur29 |
| 212 | 64 | 19 | .93 | .35 | 1.31 | 1.0 | 1.27 | .9 | .78 | .63 | 47.4 | 52.9 | mm_learn23 |
| 110 | 73 | 19 | -.30 | .39 | 1.30 | .9 | 1.29 | .9 | .56 | .60 | 57.9 | 63.6 | pr_pur23.1 |
| 83 | 71 | 19 | -.01 | .38 | 1.25 | .8 | 1.30 | .9 | .54 | .61 | 63.2 | 62.6 | pr_plan11.16 |
| 105 | 80 | 19 | -1.41 | .41 | 1.28 | .9 | 1.29 | .9 | .43 | .56 | 63.2 | 61.6 | pr_pd18.8 |
| 80 | 74 | 19 | -.45 | .39 | 1.21 | .7 | 1.28 | .9 | .52 | .59 | 52.6 | 63.5 | pr_plan11.13 |
| 81 | 65 | 19 | .81 | .36 | 1.28 | .9 | 1.23 | .8 | .53 | .63 | 52.6 | 54.0 | pr_plan11.14 |
| 135 | 77 | 19 | -.92 | .40 | 1.28 | .9 | 1.25 | .8 | .52 | .58 | 52.6 | 62.5 | pr_pur26.6 |
| 93 | 63 | 18 | .61 | .37 | 1.26 | .8 | 1.18 | .6 | .52 | .63 | 55.6 | 57.4 | pr_pd15.2 |
| 115 | 71 | 19 | -.01 | .38 | 1.17 | .6 | 1.24 | .8 | .50 | .61 | 57.9 | 62.6 | pr_pur23.9 |
| 10 | 76 | 19 | -.76 | .40 | 1.24 | .8 | 1.16 | .6 | .57 | .58 | 57.9 | 62.3 | mr_cf16 |
| 50 | 70 | 19 | .14 | .38 | 1.23 | .8 | 1.24 | .8 | .55 | .61 | 47.4 | 61.6 | rm_iwe41 |
| 154 | 79 | 19 | -1.24 | .41 | 1.24 | .8 | 1.20 | .7 | .54 | .56 | 63.2 | 62.3 | pr_seo41.5 |
| 159 | 70 | 19 | .14 | .38 | 1.14 | .5 | 1.22 | .7 | .47 | .61 | 63.2 | 61.6 | mm1.4 |
| 51 | 66 | 19 | .68 | .36 | 1.21 | .7 | 1.16 | .6 | .68 | .62 | 42.1 | 55.7 | rm_iwe42 |
| 114 | 79 | 19 | -1.24 | .41 | 1.21 | .7 | 1.21 | .7 | .55 | .56 | 52.6 | 62.3 | pr_pur23.6 |
| 194 | 73 | 19 | -.30 | .39 | 1.20 | .7 | 1.14 | .5 | .41 | .60 | 68.4 | 63.6 | mm_imp2 |
| BETTER FITTING OMITTED | | | | | | | | | | | | | |
| 181 | 69 | 19 | .28 | .37 | .85 | -.3 | .78 | -.6 | .82 | .62 | 68.4 | 60.4 | mm15.3 |
| 162 | 66 | 19 | .68 | .36 | .77 | -.6 | .83 | -.4 | .76 | .62 | 78.9 | 55.7 | mm1.7 |
| 198 | 70 | 19 | .14 | .38 | .79 | -.5 | .82 | -.5 | .63 | .61 | 68.4 | 61.6 | mm_imp7 |
| 207 | 68 | 19 | .41 | .37 | .80 | -.5 | .78 | -.6 | .68 | .62 | 73.7 | 59.3 | mm_learn18 |
| 11 | 72 | 19 | -.15 | .38 | .79 | -.5 | .80 | -.5 | .67 | .60 | 63.2 | 63.3 | mr_cf17 |
| 76 | 71 | 19 | -.01 | .38 | .76 | -.6 | .80 | -.5 | .64 | .61 | 57.9 | 62.6 | pr_plan11.9 |
| 174 | 72 | 19 | -.15 | .38 | .75 | -.7 | .80 | -.5 | .61 | .60 | 63.2 | 63.3 | mm12.2 |
| 189 | 73 | 19 | -.30 | .39 | .79 | -.5 | .72 | -.8 | .52 | .60 | 84.2 | 63.6 | mm19.2 |
| 24 | 65 | 19 | .81 | .36 | .79 | -.6 | .75 | -.7 | .57 | .63 | 52.6 | 54.0 | rm_fin4 |
| 166 | 67 | 19 | .55 | .36 | .77 | -.6 | .79 | -.6 | .64 | .62 | 68.4 | 57.8 | mm5 |
| 183 | 65 | 19 | .81 | .36 | .78 | -.6 | .73 | -.8 | .75 | .63 | 63.2 | 54.0 | mm17.1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 68 | 19 | .41 | .37 | .76 | -.7 | .78 | -.6 | | .60 | .62 | 52.6 | 59.3 | rm_fin5 |
| 148 | 78 | 19 | -1.08 | .40 | .78 | -.6 | .74 | -.7 | | .48 | .57 | 73.7 | 62.5 | pr_seo35.1 |
| 8 | 73 | 19 | -.30 | .39 | .74 | -.7 | .77 | -.6 | | .67 | .60 | 68.4 | 63.6 | mr_mc10 |
| 190 | 73 | 19 | -.30 | .39 | .75 | -.7 | .76 | -.7 | | .72 | .60 | 68.4 | 63.6 | mm20 |
| 180 | 67 | 19 | .55 | .36 | .75 | -.7 | .76 | -.7 | | .76 | .62 | 73.7 | 57.8 | mm15.2 |
| 136 | 77 | 19 | -.92 | .40 | .73 | -.8 | .74 | -.7 | | .59 | .58 | 63.2 | 62.5 | pr_pur28 |
| 64 | 65 | 19 | .81 | .36 | .74 | -.8 | .72 | -.9 | | .81 | .63 | 52.6 | 54.0 | pr_plan4 |
| 29 | 73 | 19 | -.30 | .39 | .73 | -.8 | .74 | -.7 | | .68 | .60 | 68.4 | 63.6 | rm_fin9 |
| 61 | 75 | 19 | -.60 | .39 | .61 | -1.2 | .72 | -.8 | | .62 | .59 | 78.9 | 62.9 | pr_plan3.3 |
| 17 | 71 | 19 | -.01 | .38 | .71 | -.8 | .72 | -.8 | | .73 | .61 | 68.4 | 62.6 | mr_rac30 |
| 210 | 61 | 19 | 1.30 | .35 | .71 | -.9 | .72 | -.9 | | .76 | .63 | 42.1 | 51.9 | mm_learn21 |
| 172 | 69 | 19 | .28 | .37 | .72 | -.8 | .67 | -1.0 | | .82 | .62 | 78.9 | 60.4 | mm11 |
| 87 | 76 | 19 | -.76 | .40 | .71 | -.8 | .68 | -1.0 | | .74 | .58 | 68.4 | 62.3 | pr_pd13.2 |
| 129 | 68 | 19 | .41 | .37 | .69 | -.9 | .71 | -.9 | | .62 | .62 | 63.2 | 59.3 | pr_pur25.8 |
| 40 | 64 | 19 | .93 | .35 | .71 | -.9 | .71 | -.9 | | .81 | .63 | 68.4 | 52.9 | rm_hrm_emp28 |
| 231 | 71 | 19 | -.01 | .38 | .68 | -1.0 | .71 | -.8 | | .75 | .61 | 68.4 | 62.6 | per_nfin14 |
| 31 | 66 | 19 | .68 | .36 | .71 | -.9 | .70 | -.9 | | .68 | .62 | 63.2 | 55.7 | rm_hrm12 |
| 203 | 64 | 19 | .93 | .35 | .71 | -.9 | .67 | -1.1 | | .85 | .63 | 57.9 | 52.9 | mm_learn11 |
| 133 | 78 | 19 | -1.08 | .40 | .70 | -.9 | .70 | -.9 | | .77 | .57 | 63.2 | 62.5 | pr_pur26.4 |
| 175 | 73 | 19 | -.30 | .39 | .70 | -.9 | .69 | -.9 | | .74 | .60 | 68.4 | 63.6 | mm12.3 |
| 98 | 73 | 19 | -.30 | .39 | .70 | -.9 | .67 | -1.0 | | .66 | .60 | 68.4 | 63.6 | pr_pd16.3 |
| 204 | 70 | 19 | .14 | .38 | .69 | -.9 | .69 | -.9 | | .74 | .61 | 68.4 | 61.6 | mm_learn13 |
| 116 | 74 | 19 | -.45 | .39 | .68 | -.9 | .69 | -.9 | | .66 | .59 | 73.7 | 63.5 | pr_pur23.10 |
| 185 | 69 | 19 | .28 | .37 | .69 | -.9 | .64 | -1.1 | | .74 | .62 | 78.9 | 60.4 | mm17.3 |
| 60 | 75 | 19 | -.60 | .39 | .68 | -1.0 | .69 | -.9 | | .62 | .59 | 78.9 | 62.9 | pr_plan3.2 |
| 123 | 70 | 19 | .14 | .38 | .66 | -1.0 | .69 | -.9 | | .42 | .61 | 68.4 | 61.6 | pr_pur25.2 |
| 90 | 74 | 19 | -.45 | .39 | .66 | -1.0 | .69 | -.9 | | .67 | .59 | 73.7 | 63.5 | pr_pd13.6 |
| 103 | 75 | 19 | -.60 | .39 | .68 | -1.0 | .68 | -.9 | | .62 | .59 | 78.9 | 62.9 | pr_pd18.4 |
| 15 | 70 | 19 | .14 | .38 | .67 | -1.0 | .67 | -1.0 | | .74 | .61 | 68.4 | 61.6 | mr_sp27 |
| 84 | 70 | 19 | .14 | .38 | .66 | -1.0 | .63 | -1.1 | | .66 | .61 | 68.4 | 61.6 | pr_plan11.17 |
| 160 | 71 | 19 | -.01 | .38 | .63 | -1.1 | .65 | -1.0 | | .61 | .61 | 68.4 | 62.6 | mm1.5 |
| 52 | 71 | 19 | -.01 | .38 | .64 | -1.1 | .65 | -1.1 | | .69 | .61 | 68.4 | 62.6 | rm_iwe43 |
| 34 | 62 | 19 | 1.18 | .35 | .61 | -1.3 | .65 | -1.2 | | .75 | .63 | 57.9 | 52.4 | rm_hrm15 |
| 92 | 65 | 18 | .33 | .38 | .63 | -1.1 | .64 | -1.1 | | .77 | .63 | 83.3 | 60.3 | pr_pd15.1 |
| 23 | 67 | 19 | .55 | .36 | .61 | -1.3 | .60 | -1.3 | | .71 | .62 | 68.4 | 57.8 | rm_fin3 |
| 193 | 73 | 19 | -.30 | .39 | .59 | -1.3 | .60 | -1.3 | | .65 | .60 | 78.9 | 63.6 | mm_imp1 |
| 111 | 69 | 19 | .28 | .37 | .58 | -1.4 | .60 | -1.3 | | .58 | .62 | 68.4 | 60.4 | pr_pur23.3 |
| 108 | 77 | 19 | -.92 | .40 | .59 | -1.3 | .59 | -1.3 | z | .69 | .58 | 73.7 | 62.5 | pr_pd21 |
| 208 | 67 | 19 | .55 | .36 | .59 | -1.3 | .57 | -1.4 | y | .81 | .62 | 78.9 | 57.8 | mm_learn19 |
| 28 | 69 | 19 | .28 | .37 | .55 | -1.5 | .59 | -1.3 | x | .65 | .62 | 57.9 | 60.4 | rm_fin8 |
| 196 | 68 | 19 | .41 | .37 | .58 | -1.4 | .53 | -1.6 | w | .80 | .62 | 73.7 | 59.3 | mm_imp4 |
| 214 | 73 | 19 | -.30 | .39 | .57 | -1.4 | .57 | -1.4 | v | .80 | .60 | 78.9 | 63.6 | mm_learn27 |
| 58 | 66 | 19 | .68 | .36 | .56 | -1.5 | .56 | -1.5 | u | .78 | .62 | 63.2 | 55.7 | pr_plan2 |
| 119 | 73 | 19 | -.30 | .39 | .54 | -1.5 | .55 | -1.5 | t | .69 | .60 | 78.9 | 63.6 | pr_pur23.13 |
| 19 | 69 | 19 | .28 | .37 | .55 | -1.5 | .54 | -1.5 | s | .73 | .62 | 68.4 | 60.4 | mr_rac32 |
| 27 | 74 | 19 | -.45 | .39 | .55 | -1.5 | .55 | -1.5 | r | .74 | .59 | 84.2 | 63.5 | rm_fin7 |
| 32 | 67 | 19 | .55 | .36 | .51 | -1.7 | .55 | -1.5 | q | .83 | .62 | 68.4 | 57.8 | rm_hrm13 |
| 20 | 71 | 19 | -.01 | .38 | .54 | -1.5 | .54 | -1.5 | p | .70 | .61 | 78.9 | 62.6 | mr_rac33 |
| 191 | 73 | 19 | -.30 | .39 | .53 | -1.5 | .54 | -1.5 | o | .69 | .60 | 78.9 | 63.6 | mm21.3 |
| 156 | 70 | 19 | .14 | .38 | .51 | -1.6 | .54 | -1.5 | n | .81 | .61 | 78.9 | 61.6 | mm1.1 |
| 18 | 70 | 19 | .14 | .38 | .54 | -1.5 | .52 | -1.6 | m | .82 | .61 | 68.4 | 61.6 | mr_rac31 |
| 66 | 67 | 19 | .55 | .36 | .54 | -1.6 | .51 | -1.7 | l | .85 | .62 | 78.9 | 57.8 | pr_plan6 |
| 67 | 70 | 19 | .14 | .38 | .50 | -1.7 | .52 | -1.6 | k | .78 | .61 | 68.4 | 61.6 | pr_plan7 |
| 132 | 72 | 19 | -.15 | .38 | .50 | -1.7 | .51 | -1.6 | j | .87 | .60 | 73.7 | 63.3 | pr_pur26.3 |
| 167 | 70 | 19 | .14 | .38 | .48 | -1.8 | .48 | -1.8 | i | .59 | .61 | 68.4 | 61.6 | mm6 |
| 192 | 70 | 19 | .14 | .38 | .48 | -1.8 | .46 | -1.9 | h | .72 | .61 | 68.4 | 61.6 | mm21.7 |
| 143 | 77 | 19 | -.92 | .40 | .48 | -1.9 | .48 | -1.8 | g | .76 | .58 | 84.2 | 62.5 | pr_seo34.4 |
| 201 | 68 | 19 | .41 | .37 | .44 | -2.0 | .43 | -2.1 | f | .85 | .62 | 84.2 | 59.3 | mm_inv9 |
| 202 | 71 | 19 | -.01 | .38 | .43 | -2.0 | .42 | -2.1 | e | .73 | .61 | 78.9 | 62.6 | mm_inv10 |
| 195 | 70 | 19 | .14 | .38 | .36 | -2.4 | .39 | -2.3 | d | .67 | .61 | 78.9 | 61.6 | mm_imp3 |
| 33 | 63 | 19 | 1.06 | .35 | .34 | -2.7 | .36 | -2.6 | c | .84 | .63 | 84.2 | 52.3 | rm_hrm14 |
| 199 | 69 | 19 | .28 | .37 | .34 | -2.6 | .36 | -2.5 | b | .71 | .62 | 78.9 | 60.4 | mm_inv8.1 |
| 200 | 68 | 19 | .41 | .37 | .29 | -2.9 | .31 | -2.8 | a | .78 | .62 | 84.2 | 59.3 | mm_inv8.2 |
| MEAN | 70.6 | 19.0 | .00 | .38 | .98 | -.1 | .99 | -.1 | | | | 62.3 | 60.4 | |
| S.D. | 5.8 | .2 | .78 | .02 | .41 | 1.1 | .48 | 1.2 | | | | 11.8 | 3.5 | |

Even though the above provide information on items outside the range but in order for the instrument to be good it should be able to avoid the items that have the same item measure. Those items with the same item measure are potentially measuring the same construct. The output Table 23.99 in the Table 5 below shows the largest standardized residual correlations used to identify dependent item.

Table 5: Largest standardized residual correlations used to identify dependent item

TABLE 23.99 ISO 9000 constructs and organization
INPUT: 19 Person 231 Item MEASURED: 19 Person 231 Item

LARGEST STANDARDIZED RESIDUAL CORRELATIONS
USED TO IDENTIFY DEPENDENT Item

| CORREL-ATION | ENTRY NUMBER Item | ENTRY NUMBER Item |
|---|---|---|
| .95 | 215 mm_learn28 | 216 mm_learn29 |
| .95 | 157 mm1.2 | 158 mm1.3 |
| .94 | 148 pr_seo35.1 | 149 pr_seo35.2 |
| .94 | 40 rm_hrm_emp28 | 42 rm_hrm_emp31 |
| .93 | 226 per_nfin7 | 227 per_nfin8 |
| .93 | 179 mm15.1 | 182 mm15.4 |
| .92 | 87 pr_pd13.2 | 108 pr_pd21 |
| .92 | 145 pr_seo34.6 | 151 pr_seo37.2 |
| .91 | 173 mm12.1 | 175 mm12.3 |
| .89 | 153 pr_seo41.1 | 168 mm8.3 |

Based on the above table those items which are highly correlated are due for further investigation. This table is only suggesting the highly correlated items but those items with the same item measures in the same dimension that require further scrutiny.

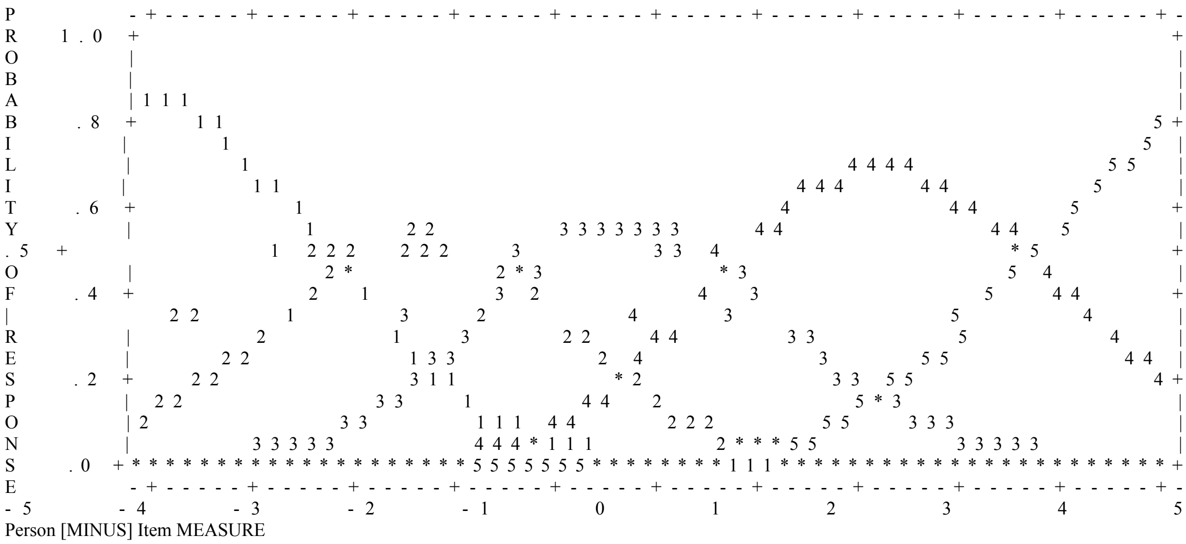
The structure calibration table is used to confirm the rating classification used is true where *s*-value being the separation between each structure category label (Bond et al., 2007). The separation shall be in the range where *s*; $1.5 < s < 5.0$. If the value of s falls less than 1.5, than the rating/s are submerged. On the opposite, if s fall greater than 5.0 than the rating should be split (Aziz, 2010). Hence in this study the separation of each category is as follows:

e.g $s_{2\text{-}3} = -1.34-(-3.04) = 1.7; > 1.5$, which is acceptable

$s_{3\text{-}4} = 0.69 -(-1.34) = 2.03; > 1.5$, which is acceptable

$s_{4\text{-}5} = 3.69 - 0.69 = 3.00; > 1.5$, which is acceptable

Figure 4. Category probabilities: modes - Structure measures at intersections




Since the calculation of s-value is within the acceptable value therefore the rating scales of 1 to 5 is remined. The above Figure 4 shows the probability curves for rating scale. It looks like the responds are fairly distributed among the categories. After further analysis was conducted on the items which are misfit by removing and restructure the questions as a result 68 items were removed from the questionnaires. The 168 items will be used for empirical research.

## 5. Conclusion

The valid and reliable instrument is very crucial in ensuring the data collected can answer the research objective. In this research the Rasch Model was used to validate the instrument. Those items that are misfit according to three types of quality controls and also those items are highly correlated among them are reviewed accordingly. As a result the items in the new instrument stood at 168 items measuring five dimensions. The empirical research may require to further investigate the study of level of ISO 9000 implementation among the automotive industries.

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